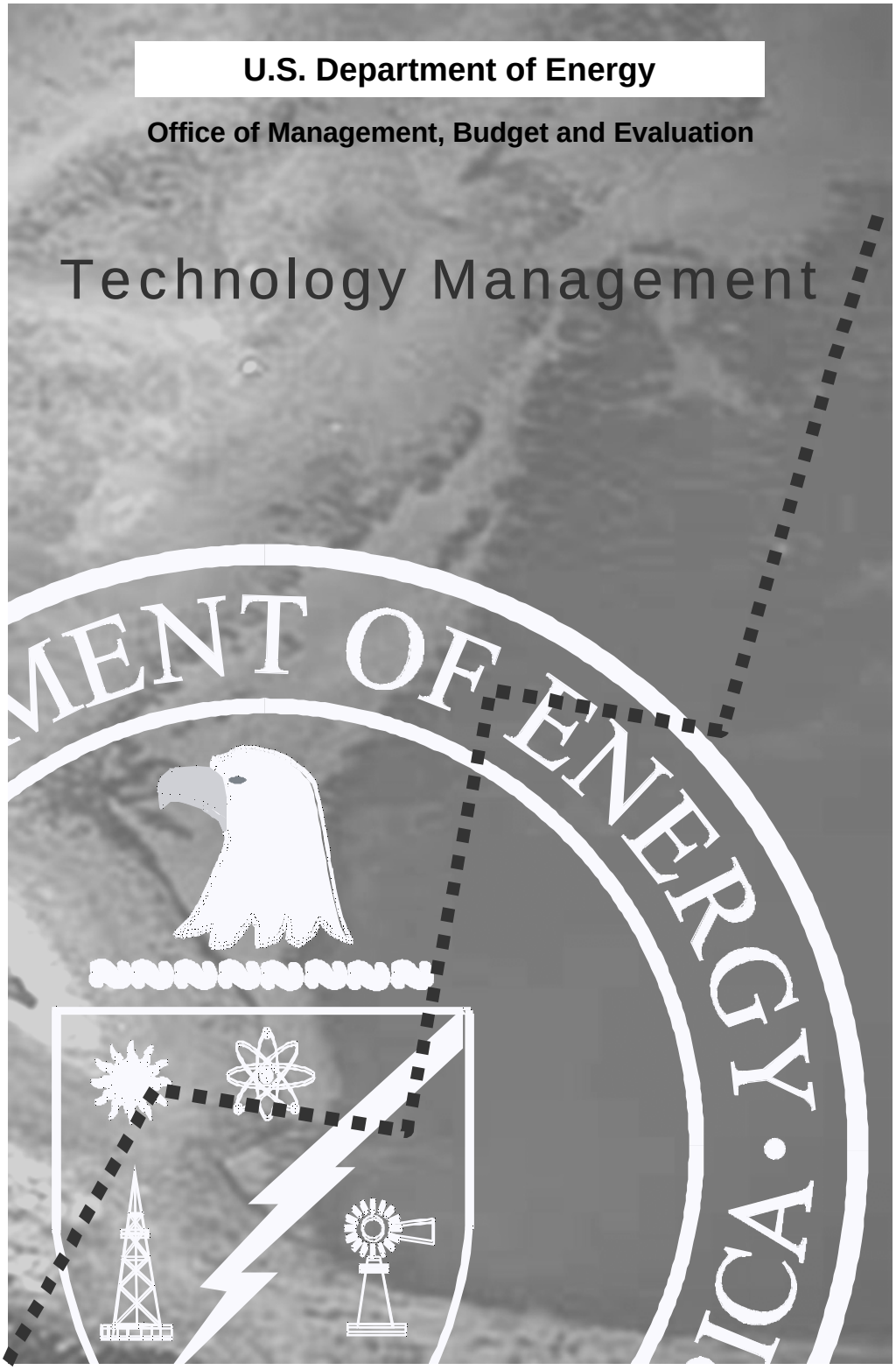
U.S. Department of Energy

Office of Management, Budget and Evaluation

Technology Management



Initiated by: Office of Engineering and Construction Management

TECHNOLOGY MANAGEMENT

1.0 INTRODUCTION

1.1 Purpose

Technology development is the process of developing and demonstrating new or unproven technology, the application of existing technology to new or different uses, or the combination of existing and proven technology to achieve a specific goal. Technology development associated with a project must be identified and completed in order to establish credible technical, schedule, and cost baselines for subsequent implementation and project control. Projects with concurrent technology development and design implementation proceed with ill-defined risks to all three baselines. The purpose of this section is to present those elements of technology development required to ensure the project satisfies its intended purpose in a safe and cost-effective manner that will reduce life cycle costs and produce results that are defensible to expert reviewers.

1.2 Scope

The scope of this chapter encompasses initial technology development and evolution of that development throughout the life cycle of the project. The following areas are addressed:

- Technology development program plans
- Process needs identification, selection and evaluation
- Performance verification
- Plant support
- Technology reviews.

2.0 REQUIREMENTS AND GUIDANCE

Various technical baseline deliverables, including associated technology development, are produced as a project evolves from pre-acquisition design to operation. Table 1 provides a matrix of the maturity level of typical deliverables at each project phase. The technology development process is not limited to the pre-acquisition and conceptual development stages, but instead, transitions throughout the life of the project. The process recognizes the evolution of the project and the iteration necessary to continue support of the design. This integrated technology development approach also addresses emerging issues related to the technology that are driven by the design process.

Figure 1 identifies the integration of technology development phases with project stages. In practice, technology development precedes design, which is followed by design implementation (construction). This is depicted in Figure 1 with bold arrows signifying completion of technology development activities supporting the follow-on design process.

The following sections provide the requirements necessary to ensure that technology development activities are brought to a level of maturity and transitioned for each project stage with a continued effort to reduce technological risk.

2.1 Technology Development Program Plans

Technology development plans are prepared when new technology development activities are identified during project planning. Technology plans provide a comprehensive planning document describing technology development activities required for the successful execution of the project, and the development relationship to the overall project scope and schedule relative to project phases. Areas addressed by the plan should include process needs identification, selection, evaluation, performance verification, and demonstrations.

In support of technology development, a roadmap is developed to provide the technology development path forward to successful deployment of the selected technology. A work scope matrix is then developed that expands on the roadmap. The matrix provides the high-level details of each segment of research and development, assigning responsibility for the execution of each segment and documenting the path through each segment in the form of logic diagrams that are linked to the roadmap.

Table 1. Project Design Phase Matrix

Initiation	Definition	Execution		Transition/Closeout
Pre-Acquisition	**Conceptual Design**	**Preliminary Design**	**Final Design**	**Construction/Startup/Turnover**
Cost: DOE approval if conceptual design costs exceed $600,000 limit **Maturity:** Need estimated conceptual design cost	**Cost:** DOE Authorization **Maturity:** Need project cost and schedule range estimate	**Cost:** Congressional funding **Maturity:** Project performance APB (TEC + OPC) including risk adjustments at Critical Decision-2	**Cost:** No special requirements to go from final design to construction—under change control **Maturity:** Critical Decision-3 approved, Critical Decision-4 complete at closeout	**Cost:** No requirements, under change control **Maturity:** Not Applicable
Schedule: No schedule requirements to go from Pre- to Conceptual Design	**Schedule:** DOE Approval **Maturity:** Need Preliminary Design schedule	**Schedule:** Project schedule **Maturity:** Project APB	**Schedule:** No special req'ts to go from final design to construction—under change control **Maturity:** Not Applicable	**Schedule:** No requirements, under change control **Maturity:** Not Applicable
Technical: Support the Conceptual Design Estimate **Maturity:** • Identify Assessments and studies • Issue Design Criteria Orders, regulations, codes & standards) • Identify Functions and Requirements • Identify Technology Development activities • Information Utilization Strategy Mission • Operational Strategy and Automation Strategy • Performance Requirements • Preliminary Vulnerability Assessment Study • Preliminary Site Clearance Permit • Review of Alternatives • Risk Assessment • Site Selection Criteria • Small-Scale testing • Systems Engineering Management Plan—Integrated Runs • Technology Dev. Program Plan a) Program R&D requirements b) Define R&D program phase	**Technical:** Support cost & schedule and CDR **Maturity:** • Complete Alternative Studies • Complete CDR • Complete FDD, approve Facility RD (funct. & ops requirements, and draft Program Requirements) • Draft System Design Descriptions • Complete conceptual Vulnerability Assessment Study • Develop Key Technical Parameters • Identity system boundaries • Identify engineering development vs. proven process • Identify permitting requirements • Draft Interface Control Documents • Identify prelim. structures & systems and prelim. safety classifications • Prepare Information Utilization Plan • Prepare Operational/Automation Plan • Preliminary Characterization and Site Selection • Complete Proof of Concept Testing • Prepare Regulatory Management Strategy • Prepare RMP • Complete NEPA (EA, EIS approved) requirements • Complete Proof of Concept Testing • Prepare Regulatory Management Strategy • Prepare RMP • Complete NEPA (EA, EIS approved) requirements	**Technical:** Engineering and dev. completed, with risk allowances for open issues **Maturity:** • Complete Accident Analysis • Component requirements identified • Configuration Mgmt. Plan issued • Facility Design Description completed • Final Site Characterization and Site Selection • Initiate Pressure Protection Plan • Process & Inst. Diagram, Rev. 0 issued • Interface Control Documents issued • Prelim layout drawings of major SSCS completed • Performance Verification a) Full-Scale Tests b) Refinement/Opt.—Engr-Scale tests • Material Balance • Reliability, Availability, Maintainability Evaluation complete • SDD at system level complete • System boundaries identified • Technology Development activities complete • Updated RMP • Value Management	**Technical:** Complete design documentation **Maturity:** • All detailed design drawings, calculations, specifications, etc. except field urn items complete • Task Plans Issued • ORR Planning and Preparation developed • Finalize Pressure Protection Plan • ORR Planning and Preparation developed • Site Clearance Permit	**Technical:** **Maturity:** • All as-builts complete • Performance Verification a) Operating Parameters Definitions b) Process Optimization • ORR Planning and Preparations complete • Construction Punch List • All test plans issued and testing complete
Safety and Hazard Analysis / Vulnerability Assessments Draft Safeguards Requirements Identification. *Supported by:* –Preliminary VM Study –Hazard Assessment Document –Proposed Process Material Flow Emergency Preparedness Hazard Survey and screen complete Hazard Assessment Document complete *Supported by* –Facility Layout –Hazardous material inventory	**Safety and Hazard Analysis / Vulnerability Assessments** Preliminary Functional Classification complete *Supported by:* –Preliminary Hazards Analysis –Selected Alternative Study Preliminary Shielding Analysis complete. *Supported by:* –Facility Layout –Radiological material location SRI Rev. 0 complete. *Supported by:* –Conceptual VM study	**Safety and Hazard Analysis / Vulnerability Assessments** • ALARA Review complete. *Supported by:* –Preliminary design • Automation and info design Approach Finalized • Preliminary Documented Safety Analysis/Preliminary Safety Analysis Report Issued • Preliminary Emergency Plan Complete *Supported by:* –Preliminary Documented Safety Analysis/ Preliminary Safety Analysis Report Rev. A –Preliminary Design –Project Cost Estimate	**Safety and Hazard Analysis / Vulnerability Assessments** • Accident Analysis complete. *Supported by:* –Final Design –Final Functional Classification • Basis for Interim Operation Complete • Critically Analysis complete. *Supported by:* –Final Design –Draft Vulnerability Assessment Report –Final Functional Classification –Administrative Controls –Final Hazards Analysis –Accident Analysis –Criticality Analysis • Final Shielding Analysis complete. *Supported by:* –Final Design • Fire Hazards Analysis Complete. *Supported by:* –Final Design –Final Functional Classification • Preliminary technical safety requirements ident. • Prelim Documented Safety Analysis / Prelim Safety Analysis Report complete. *Supported by:* –Emergency Action Levels	**Safety and Hazard Analysis/ Vulnerability Assessments** • Emergency Preparedness Haz Assessment • Final Fire Hazard Analysis complete. *Supported by:* –Final Drawings –Walk-down –Tests • Documented Safety Analysis/ Final Safety Analysis Report. *Supported by:* –As-builts –Final Hazards Assessment –Startup test results –Site Safeguards and Security Plan –Safeguards and Security Management Report –Final Vulnerability Assessment Report –Tests (force on force) • Technical Safety Requirements complete. *Supported by:* –Documented Safety Analysis/Final Safety Analysis Report

Life Cycle of a Project Phase

Pre-Acquisition	Conceptual	Design/Construction			Acceptance	Operation
R&D Input Facility Feedback	Permit Requirements Facilities Scope Facility Feedback	**Preliminary Design** Project Authorization Project Schedule Facility Scope Facility Feedback	**Final Design** Source Documents Facility Feedback	**Construction** Construction Permits Construction Feedback	• Startup Testing • Verification of Performance	• Project Closeout
R&D Input Assessments and Studies Review of Alternatives Small-Scale Testing Safety Strategy Input	R&D Input • Proof of Concept Testing	Engineering Development • Full-Scale Test • Process Refinement and Optimization • Engineering-Scale Test • Integrated Runs	Engineering Development	Engineering Development	Process Support • Startup Support	Continuous Improvement
Process Needs Identification Selection		**Performance Verification**			**Plant Support**	

Technology Development Phase

Figure 1. Technology Development Integration with Project Management

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2.1.1 Process Needs Identification, Selection, and Evaluation

Process needs identification, selection, and evaluation occur during the pre-acquisition and conceptual design stages. Within these stages, the technology development program identifies and quantifies the needs and requirements of a system or component and associated risks. This may include laboratory or pilot work to better understand system or process performance. The product of these activities provides input to performance requirement documents and criteria.

The next step in this effort involves selecting equipment that meets the performance requirements or criteria. In the selection process, existing developed equipment or processes are utilized to the maximum extent possible. However, in many cases, particularly those processes performed in hazardous or remote environments, the equipment may not be commercially available. In these situations, efforts are made to adapt commercial technologies to the specific environment and requirements. During this activity, the available equipment is compared and those identified as most closely meeting the defined requirements are selected for further evaluation.

Equipment and or process evaluation involves experimental or pilot facility testing of the process or equipment identified in the selection process. Although selection identified those processes and equipment that most closely meet design requirements, it is not uncommon for evaluation of those selected processes and equipment to identify areas where the process or equipment fails to meet requirements. In those cases, it may be necessary to return to the selection process to evaluate alternatives to the selected option.

The following subsections describe various activities used to support the identification, selection, and evaluation of the selected technology.

Assessments and Studies

Inherent with technology development is the risk associated with first-of-kind applications. A technical risk assessment should be performed to identify risks that may affect the achievement of technical objectives that ultimately affect schedule, cost, and performance. Results of technical risk assessments and risk-handling strategies are factored into technical assessments and studies (see the Practice on Risk Management).

Technical assessments and studies are conducted during the pre-acquisition project stage to evaluate and select the design approach that best meets the customers' goals, objectives, and preliminary technical and functional requirements. Topics addressed during this activity should include, as applicable, process technology, facility concepts, major system concepts, component technology, and risk-handling strategies identified through completion of technical risk assessments.

Review of Alternatives

Results of technology development assessments and studies are documented and reviewed to determine the validity of the approach that best meets project goals, objectives, and the physical, functional, performance, and operational requirements of the project—at the least cost.

A team, consisting of members from the customer, engineering, operations and maintenance organizations, technology development program management, and selected subject matter experts, reviews the assessment and study results. The team review focuses on the results of the assessments and studies relative to the alternatives considered, evaluation of systems used to select the recommended design approach, and the potential cost savings. The objective of the review is to endorse the selected design approach, including development and testing of the technology development in subsequent project phases.

Small-Scale and Proof-of-Concept Testing

Small-scale and proof-of-concept testing is performed at the conceptual project stage to verify initial assumptions relative to system and process performance. Test results are compared with the initial input parameters. Based on the review of test results, refinements may be applied to assure that the technology concept meets project requirements prior to the start of project design activities.

2.2 Performance Verification

Performance verification occurs during the design and construction project stages. Once a process and or equipment has been selected and proven to perform in an acceptable manner, verification against the design requirements is performed to ensure that the process or equipment will perform properly in the operating environment. Verification addresses performance of the selected process and or equipment on both the component level and from an integrated systems perspective. Verification attributes may include checking that the operating parameters are within the operating envelope of supporting systems (e.g., power, feed rate, etc.) as well as meeting the physical expectations of the equipment and remote operation, or examining properties of material produced against the stated requirements.

Following verification activities, full-scale testing to assess the durability and reliability of the process and/or equipment is conducted. Integrated runs involving combining components, systems, or processes are performed to provide a demonstration of process conditions over extended periods of time and provide opportunities for process optimization. This testing stage is intended to prove that the long-term operating goals, especially where remote operations are required, can be reliably achieved while producing the end product at acceptable quality standards in a safe and controlled manner.

2.3 Plant Support

Following construction completion, support for the new technology is provided through start up and turnover to operations. This continued integration of technology development provides an opportunity for the operations technical staff to attain a better understanding of the technology application.

2.4 Technology Reviews

Technology review boards may be established to provide recommendations to the customer in terms of technology readiness and maturity. These boards serve in an advisory capacity at key project design points such as Critical Decision-1, Critical Decision-2, etc. Board membership consists of senior-level technical personnel and for continuity, key project personnel. The board is able to leverage outside experts as appropriate to contribute to the review process. A technology review report is issued after each review presenting the results of the review and specific recommendations relative to the design process.

Ad hoc teams of subject matter experts may perform additional technology development reviews at any point in the development process. These reviews target specific areas of development. The results from these reviews and recommendations are communicated to the project team and user.

3.0 RECORDS

Record retention is usually dictated by customer requirements. Typically project files are maintained through the various project phases until closeout. Because of the significant documentation generated by technology development activities, prudent judgment should be exercised prior to discarding any documented plans, reports, or studies utilized to validate technology development selection and test results.

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